Original Article

An Evaluation of Buccal Shield Treatment

A Clinical and Cephalometric Study

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ABSTRACT

Objective: To evaluate the short-term effects of the buccal shield modification of the lip-bumper design and on various mandibular dental arch parameters and to determine whether the changes in arch widths are due to the tipping or bodily movements of the teeth involved.

Materials and Methods: This study included 45 consecutively treated patients (29 girls and 16 boys) from a private orthodontic practice. Student's and paired *t*-tests were used to test the null hypothesis of no change over time for the various measurements. Linear regression analyses were used to determine whether treatment time was a significant predictor of arch width expansion. Significance for all statistical tests was predetermined at $P \leq .05$.

Results: Student's *t*-test results indicated the presence of a significant ($P < .0001$) increase in all the arch parameters measured. The greatest mean expansion was observed at the first (5.0 $\pm$ 2.2 mm) and second (3.4 $\pm$ 2.2 mm) premolar width measurements. The changes in arch width parameters were significantly ($P < .0001$) greater than the normal age-related changes in the corresponding parameters. There was no significant difference between arch width expansion of the occlusal vs gingival levels, indicating a bodily and not tipping movement. Only 30% of the lower incisors demonstrated an increase in their proclination beyond normal values.

Conclusion: When using the buccal shield appliance, the mandibular arch width parameters can be expanded in the mixed dentition with bodily movement of teeth. The expanded arch width dimensions are greater than what would be expected as a result of normal growth.

KEY WORDS: Lip bumper; Buccal shields

INTRODUCTION

Bjerregaard et al[1] evaluated the effects of a mandibular lip bumper and a maxillary bite plane on tooth movement in 11 children with deep overbite and moderate mandibular space deficiency in the late mixed dentition. They reported that the average increase in arch length was 6.3 mm with no significant difference between the right and left sides. The average arch width measured between the lower first molars increased by 2.9 mm, overbite was reduced by 2.6 mm, and overjet was reduced by 0.6 mm. The cephalometric analysis indicated that the dental changes consisted of labial tipping of the lower incisors and distal tipping of the lower molars.

In a prospective study, Davidovitch et al[2] used dental casts as well as lateral and tomographic radiographs to determine the effects of 6 months of continuous lip-bumper therapy on patients with mild to moderate mandibular crowding. They found significant increases in incisor inclination, arch length, and arch perimeter between the treated and untreated subjects. Osborn et al[3] similarly evaluated the effects of the lip bumper used on 32 patients in the late mixed and early permanent dentitions. They found that, on average, arch circumference increased by 4.1 mm and arch length increased by 1.2 mm as a result of incisor tipping, whereas arch widths increased by 2.0 mm at the canines and 2.5 mm at the first premolars.

Murphy et al[4] measured the rate of expansion with a mandibular lip bumper in a longitudinal study. Their findings indicated that about 50% of the total expansion occurred in the first 100 days, 40% occurred in the next 200 days, and only 10% occurred after the first 300 days. As a result, they suggested that there

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Figure 1. (A) Lateral view illustrating tie-back hooks, Guerin lock, and acrylic shield. (B) Frontal view of the anterior segment of the lip bumper at the gingival margin of the mandibular incisors. (C) Occlusal view illustrating the anterior segment of the buccal shield 2 mm away from the incisor area and 4, 8, and 2 mm wider in the canine, second premolar, and molar areas, respectively.

is little benefit for having the appliance in place after that period. Furthermore, they observed that the amount of mandibular expansion was not related to whether the patient had concomitant maxillary expansion.[4]

Nevant et al[5] evaluated the effects of two types of lip bumpers on two groups of 20 patients. In one group, the bumper was fabricated from stainless steel round wire covered with shrink tubing as suggested by Cetlin and Ten Hoeve[6] and was activated every 2 to 3 months. The second group was treated with broader prefabricated lip bumpers covered with acrylic shields from canine to canine and was activated every 4 to 5 weeks. Both groups showed similar effects on the lower incisor position, but the group with the prefabricated acrylic shield showed more molar tipping and greater transverse expansion of the canines and premolars.[5]

The buccal shield modification of the lip bumper was introduced in 1989 to further improve both the efficiency of the appliance as well as patient comfort.[7] The buccal shield design was further modified to make it more convenient to adjust (Figure 1A), specifically by replacing the stopped loops with Guerin locks (3M Unitek, Monrovia, Calif). This allows the buccal shield to be fabricated on the original study models, and future activations can be made by moving the Guerin lock to the desired position. This new design eliminated the problems associated with the stopped loops, including tissue irritation and appliance breakage. In addition, it facilitated as well as increased the range of activation of the lip bumper for the duration of treatment. For uncooperative patients, an elastic or wire ligature can be tied between the hooks on the molar bands, and hooks soldered to the bumper wire.

The purpose of this study was to evaluate the buccal shield modification of the lip-bumper design on various mandibular dental arch parameters and on the inclination of the mandibular incisors. Another purpose was to determine whether the changes in arch widths were due to the tipping or bodily movements of the teeth involved.

MATERIALS AND METHODS

Subjects

The present study included 45 consecutively treated patients (29 females and 16 males) from a private orthodontic practice. The same orthodontist treated all patients in the mixed dentition stage of dental development, which was defined as the presence of at least four mandibular incisors and two permanent first molars. The buccal shield appliance was used as a part of the first stage of orthodontic treatment before the use of fixed appliances. All patients had complete diagnostic pretreatment records as well as progress records taken before the placement of fixed appliances. Progress records included mandibular impressions, lateral cephalograms, and intraoral photographs.

Appliance Fabrication

A 0.045-inch Nubryte wire (GAC International Islip, Long Island, NY) was shaped to the form of the mandibular dental casts. The midline and the points distal to the lateral incisors were marked on the wire. A 2- to 4-mm step-up bend was made at the distal of the lateral incisors to allow the anterior segment of the wire to be at a lower level than the posterior segment (Figure 1B).

The wire was bent approximately 4 to 8 mm wider (ie, away from the canines and second premolars, respectively) (Figure 1C). As the wire enters the molar tubes, toe-in or inset bends may be needed depending on the angulation of the molar tubes buccolingually. When passive, the wire should be 2 to 3 mm wider than the molar tubes to prevent the rolling-in of the molars caused by the pressure of the cheeks on the buccal shields. When the wire was inserted in the molar tubes, there was still a 3- to 5-mm space between the appliance and the canines and second premolars. The wire was left extending a few millimeters distally from the buccal tubes to allow future activation of the lip bumper.

A piece of plastic tubing (Orthoband Corp, Barnhart, Mo) was slipped onto the wire and placed at the anterior segment extending between the two canines. The plastic tubing was heated carefully with a flame for it to shrink and fit the wire snugly. If a tie-back hook is desired, it should be soldered to the wire at this time (Figure 1A).

To construct the buccal shield, cold cure acrylic was made into a roll and pressed against the wire in the premolar area, forming a 5-mm wide shield. To minimize the seepage of saliva or food particles through the plastic tubing, it is desirable to seal the ends of the tubing by extending the buccal shields forward. This will improve oral hygiene and slow the discoloration of the plastic tubing.

Dental Cast Analysis

Measurements were obtained from the mandibular dental casts with a Beerendonk Dental Vernier (Dentaurum, Newtown, Pa) accurate to the nearest 0.1 mm.

Arch width measurements were taken at both the occlusal and cervical levels. At the occlusal level, arch width was measured between the canine cusp tips, between the buccal cusp tips of the deciduous first molars or first premolars, at the middle of the central groove for the deciduous second molars or second premolars, and between the central fossae for the permanent first molars.

Measurements of arch width at the cervical level were taken between the most prominent points at the buccal gingival margin of the canines, premolars, and deciduous molars and at the gingival margin of the mesiobuccal line angle for the permanent first molars.

Arch length was measured as the perpendicular from the contact point between the two mandibular central incisors to a line connecting the mesial contact points of the mandibular right and left permanent first molars.

Measurements were obtained from the records taken at pretreatment and at the completion of treatment with the buccal shield.

Cephalometric Analysis

Cephalograms were traced with a 0.5-mm lead pencil on acetate paper. The mandibular incisor inclination (IMPA) was measured as the angle between the long axis of the most prominent incisor and the mandibular plane (Go-Gn).

The same investigator marked and checked for accuracy all landmarks at two different time intervals and also measured each parameter twice at two different time intervals. Reliability was predetermined at 0.5 mm.

Statistical Analysis

Descriptive statistics (means, standard deviations, and ranges) were calculated for the mandibular arch widths, arch length, and IMPA angle at pre- and post buccal shield treatment. Student's *t*-tests were used to test the null hypothesis of no change over time for the various measurements.

To assess whether the changes were due to normal growth or to the effects of the buccal shield appliance, the mean changes in three arch width parameters in the treatment group were compared with the mean changes obtained on the same parameters in an untreated control group.[8] Two-sample *t*-tests with unequal variances were used to test the null hypothesis of no difference between the treatment and control groups.

To determine whether the expansion was due to crown tipping or bodily movement, the measurements at the cervical region were compared with the corresponding measurements at the occlusal level. Paired *t*-tests were used to test the null hypothesis of no difference between the changes at the cervical and occlusal levels of the teeth. Because some teeth were not fully erupted, their gingival measurements were not taken. Therefore, the comparisons were conducted on the pairs of measurements that were complete. Linear regression analyses were used to determine whether treatment time was a significant predictor of arch width expansion. Significance for all statistical tests was predetermined at $P \leq .05$.

RESULTS

Student's *t*-test results indicated the presence of a significant ($P < .0001$) increase in the parameters measured. The greatest mean expansion was observed at the first (5.0 $\pm$ 2.2 mm) and second (3.4 $\pm$ 2.2 mm) premolar width measurements. Less expansion occurred in the intercanine (2.4 $\pm$ 2.0 mm) and intermolar (2.4 $\pm$ 2.6 mm) arch widths. However, arch length increased on average 1.6 $\pm$ 2.1 mm (Table 1).

When representative arch width parameters in the treated group were compared with the corresponding parameters in the untreated control obtained from the Harvard sample by Moorrees,[8] treatment with the buccal shield appliance yielded significantly ($P < .0001$) greater arch width changes than in the untreated controls (Table 2).

There were no significant differences between the mean arch widths changes at the occlusal and cervical levels for the respective arch width dimensions (Table 3). These findings indicated that as a result of the use of the buccal shield appliance, bodily tooth movement occurred at the canines and premolars rather than coronal tipping.

TABLE 1. Descriptive Statistics for the Changes in the Mandibular Arch Parameters Before and After Buccal Shield Treatment[a]

Measurement	Number	Mean	SD	Range
c-C cusp tip, mm	36	2.4	2	−1.5 to 6.7
c-C cervical, mm	34	2.3	1.8	−0.7 to 6.4
D-PM_1 cusp tip, mm	39	5	2.2	1.4 to 12.0
D-PM_1 cervical, mm	35	4.7	2.6	1.6 to 13.4
E-PM_2 fossa, mm	37	3.4	2.2	−0.7 to 7.7
E-PM_2 cervical, mm	37	3.7	2	−0.3 to 8.8
M_1-M_1 fossa, mm	44	2.4	2.6	−2.0 to 9.9
M_1-M_1 cervical, mm	44	3.1	2.4	−0.6 to 10.8
Arch length, mm	44	1.6	2.1	−1.5 to 8.0
IMPA, °	43	1.2	4.1	−10.0 to 9.0
Treatment time, mo	45	15.7	7.6	4.5 to 41.0

[a] c-C indicates deciduous canine–permanent canine; D-PM_1, deciduous first molar; E-PM_2, deciduous second molar; M_1-M_2, permanent first molar; and IMPA, mandibular incisor inclination (L1-GoGn).

The changes in the IMPA angle during treatment are presented in Table 1. There was an average increase in the IMPA angle of 1.2 ± 4.1°. The range of changes in the IMPA values as a result of treatment is of some interest and indicated that the IMPA angle decreased in 18 patients, increased in 22 patients, and remained the same in 3 patients (Table 4).

The mean treatment time (Table 1) was 15.7 ± 7.6 months. The results of the linear regression analysis indicated that treatment time was not a significant covariate in arch width expansion (Table 5).

DISCUSSION

Interest in the early intervention of tooth size arch length deficiencies (TSALDs) is increasing. It has been suggested that the use of lip bumpers increases the mandibular arch length by the distal movement of the molars and the labial movement of the incisors, thereby reducing crowding and excessive overjet.[1,9,10] In the present study, we found that IMPA decreased in 41% of the patients and either did not change or increased toward 90° in 25% of patients. IMPA increased beyond 90° in only 30% of patients (Table 4).

Our results indicate that length of treatment did not correlate with arch width expansion. This is in agreement with the findings of Murphy et al,[4] who found most of the expansion is achieved in the first year of treatment.

TABLE 3. Paired *t*-Test Comparisons Indicating the Absence of Significant (>.05) Difference Between the Magnitude of Expansion at the Cusp Tip and Cervical Level for the Canines First and Second Premolars

Outcome	Number of Pairs	*t*-Test	*P*-Value
Canines	34	0.9857	.3315
First premolars	35	1.3866	.1746
Second premolars	37	−1.7321	.0918

Most orthodontists agree that expansion of the arches can be accomplished in most cases, but they question as to whether the correction can be stable.[11] Nance[11,12] stated that buccal expansion in the mandibular arch was unstable and that intercanine width returned to pretreatment values in all cases. He was concerned with maintaining the physiological balance by keeping the teeth over basal bone. In a long-term study on patients expanded in the mixed and early permanent dentitions, Little et al[13] observed that in the majority of the patients the final arch length was less than at the end of active treatment, with only three patients showing either a gain or no loss of arch length postretention. The authors also found that intercanine arch width decreased after treatment regardless of whether the arch was expanded during treatment.

Another contrasting report[14] looked at orthodontically treated cases in the late mixed or early permanent dentition in which 92% of the 57 patients had an increase in the intercanine distance during treatment. After a 4- to 6-year retention period and a 4- to 6-year observation period postretention, it was reported that 68% of the patients still retained some of the added intercanine width. This report concluded that patients can be treated with canine expansion and that a significant part of this expansion can be maintained.

Using rapid palatal expansion and lip bumper, Vanarsdall et al[15] found an increase in the basal structure of both the maxillary and mandibular widths as measured from posteroanterior cephalograms.

Established norms for the growth of the dentition have been published by Moorrees,[8] Moorrees and Reid,[16] and Moyers et al.[17] In his evaluation of un-

TABLE 2. Arch Width Changes (mm) in Untreated Controls[10] and the Changes in the Corresponding Parameters After the Use of the Buccal Shield Appliance

	Untreated Controls			Treated Group				
Outcome	Number	Mean	SD	Number	Mean	SD	*t*-Test	*P*-Value
c-C cusp tip	91	−0.60	0.97	36	2.4	2.0	8.61	<.0001
D-PM_1 cusp tip	55	0.16	0.77	39	5.0	2.2	13.18	<.0001
E-PM_2 fossa	68	0.46	0.80	37	3.4	2.2	7.85	<.0001

[a] c-C indicates deciduous canine–permanent canine; D-PM_1, deciduous first molar; and E-PM_2, deciduous second molar.

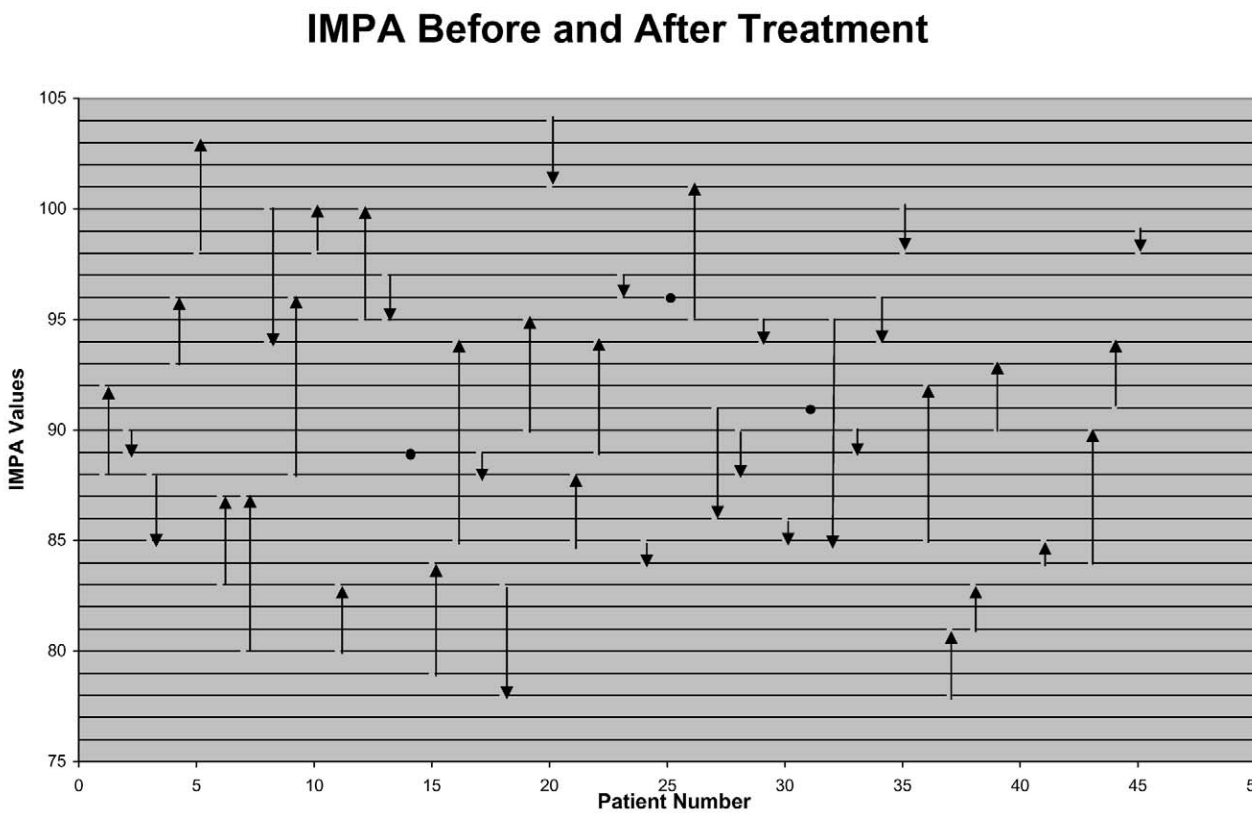

Table 4 Changes in IMPA. Beginning and tip of the arrows represent IMPA values of pre and post buccal shield treatment respectively. No change in IMPA is depicted with a black dot.

TABLE 5. Results of Linear Regression Analysis Indicating That Treatment Time Is Not a Significant Predictor (*P*-Value) of Arch Width Expansion[a]

Outcome	Parameter	Estimate (SE)	*P*-Value
c-C cusp tip	Intercept	2.39 (0.74)	.0029
	Time	0.003 (0.04)	.9465
D-PM_1 cusp tip	Intercept	4.77 (0.79)	.0002
	Time	0.02 (0.05)	.7147
E-PM_2 fossa	Intercept	2.58 (0.86)	.0047
	Time	0.05 (0.05)	.3126

[a] c-C indicates deciduous canine–permanent canine; D-PM_1, deciduous first molar; and E-PM_2, deciduous second molar.

crowded dentitions, Moorrees[8] showed that an increase in the deciduous intercanine width occurs mainly during the eruption of the permanent lateral incisors. The average increase at the gingival and incisal areas of the deciduous mandibular canines was 2.4 mm and 1.1 mm, respectively.[16]

Moyers et al[17] observed an increase in the mean intercanine width measurement of 2.1 mm at the incisal level. Williams and Ceen[18] reported an increase in intercanine width of 3.0 mm in the mandible between the ages of 3 to 18 years, whereas the intermolar width increased 2.0 mm. Also, intermolar width showed a steady increase throughout adolescence, whereas intercanine width increased rapidly until the primary canines were shed and then decreased about 1.0 mm.

Various examples of the changes that occurred in the shape and size of the mandibular arch as a result of treatment with the buccal shield appliance in a number of patients are illustrated in Figure 2. In all cases there was a spontaneous alignment of the dentition.

It needs to be emphasized that the extraction-nonextraction decision is not solely made on the basis of the TSALDs. Other important factors should also be considered, including the patient profile, inclination of the lower incisors and their periodontal status, ethnicity, the need for dental compensations, the severity of the anteroposterior and vertical discrepancies, and the patient growth potential. The decision of whether to expand the arches or to extract should be made with all these factors in mind. There still is a need for more long-term prospective studies to determine if such expansion therapies are stable after the completion of orthodontic treatment and retention.

CONCLUSIONS

- The buccal shield appliance can expand the man-

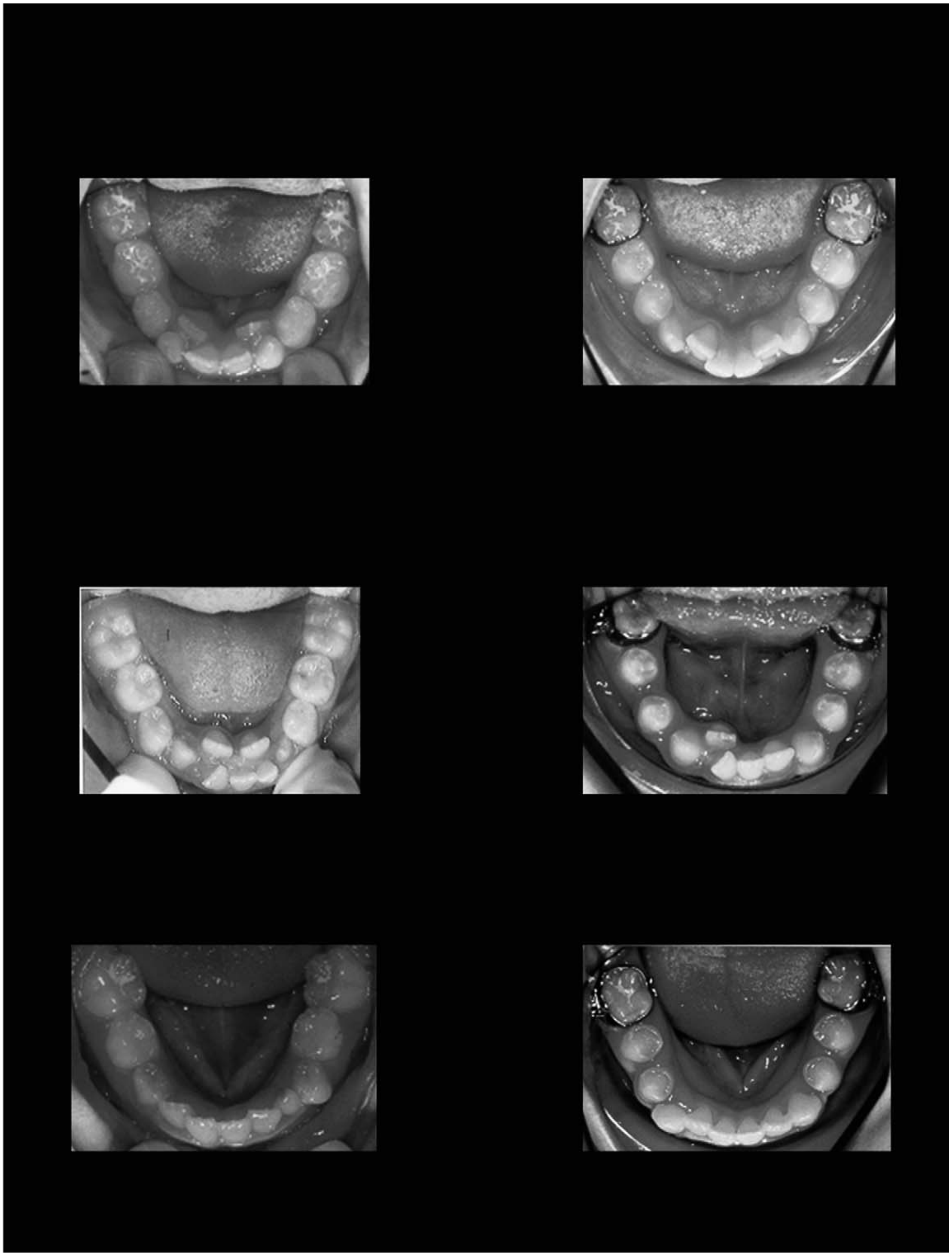

Figure 2. Clinical examples illustrating the changes that occurred in the mandibular arch parameters as a result of buccal shield treatment. Case 1: An 8-year-old girl. Lower arch expansion; c-C = 5.9 mm, D-PM_1 = 6.6 mm, E-PM_2 = 6.2 mm, M_1-M_1 = 9.9 mm, arch length increase = 4.5 mm, and IMPA increased 4°. Case 31: An 11-year-old girl. Lower arch expansion; c-C = 6.7 mm, D-PM_1 = 7.7 mm, E-PM_2 = 6 mm, M_1-M_1 = 2.1 mm, arch length increase = 8 mm, and no change in IMPA. Case 41: An 11-year-old girl. Lower arch expansion; D-PM_1 = 8.5 mm, E-PM_2 = 6.1 mm, M_1-M_1 = 6.9 mm, arch length increase = 2.7 mm, and IMPA increased 1°. Note the missing lower right deciduous canine. c-C indicates inter–deciduous canine–permanent canine width; D-PM_1, inter–deciduous first molar–first premolar width; E-PM_2, inter–deciduous second molar–second premolar width; and M_1-M_1, inter–permanent first molar width.

dibular arch width parameters in the mixed dentition with bodily movement of teeth.
- The expanded arch width dimensions are greater than what would be expected as a result of normal growth.

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